Physics and Detector simulation and MuCol WP2 meeting

# Detector concept at 10 TeV: Christmas version

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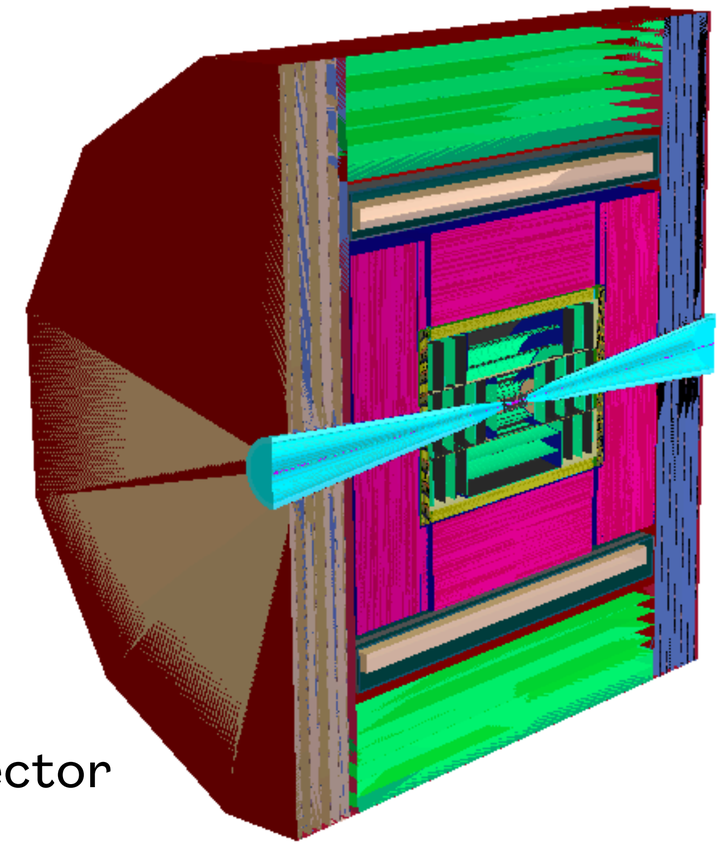
# Introduction

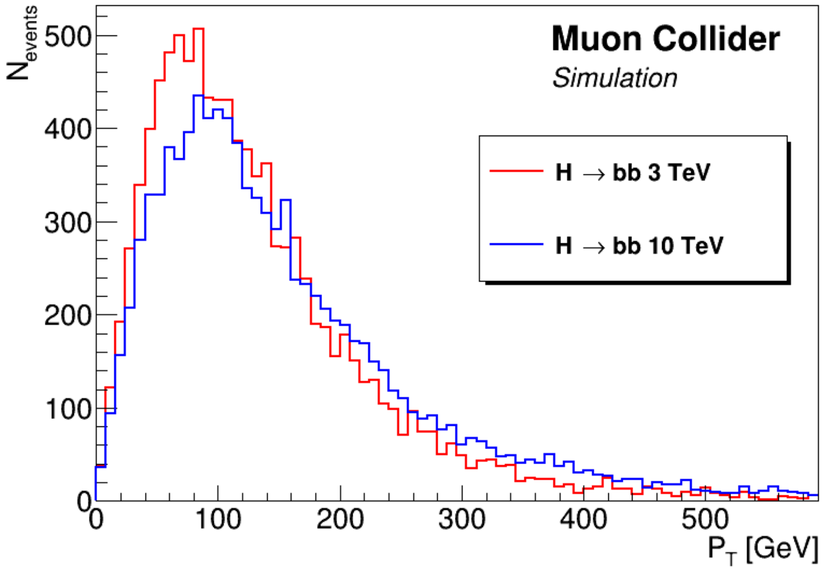
- The main task of the WP2 2.1 is the design of the detector concept for 3 and 10 TeV Muon Collider
- So far:
  - Started from CLIC detector concept
  - Revised IR and VTX detector with the insertion of nozzles
  - BIB studied at 1.5 TeV from MARS simulation

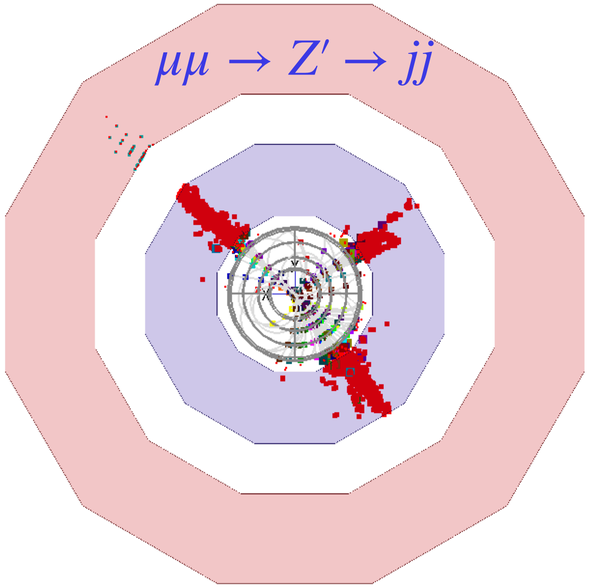


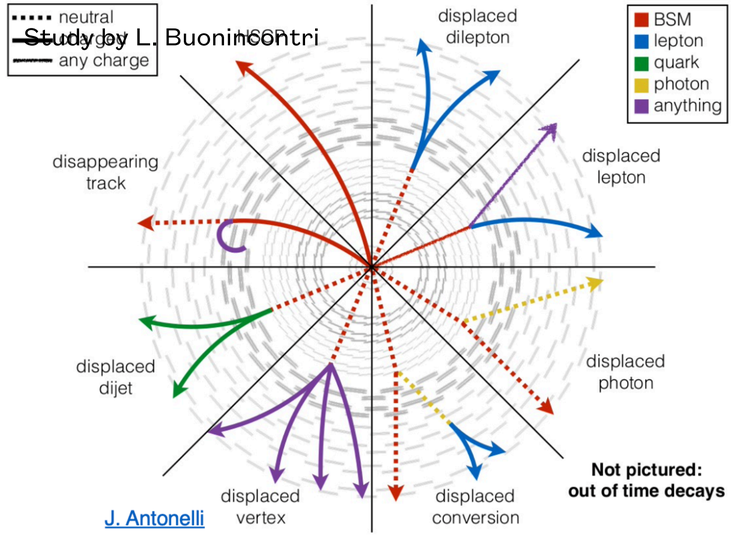
- MDI people are working on both 3 and 10 TeV BIB
- Effort by Federico on developing “a la ATLAS” detector
- Today: first steps towards implementation of 10 TeV “a la CLIC” detector

# Starting from the physics case

- When designing a detector, we must first consider the physics that we want to study
- We have found 3 physics cases (as defined in the IMCC interim report):
  - “Low” energy physics processes (EW, Higgs production) ~ hundreds of GeVs
  - “High energy physics processes (New Physics, resonance production) ~ order of TeVs
  - Unconventional signatures (long-lived particles, disappearing tracks, …)



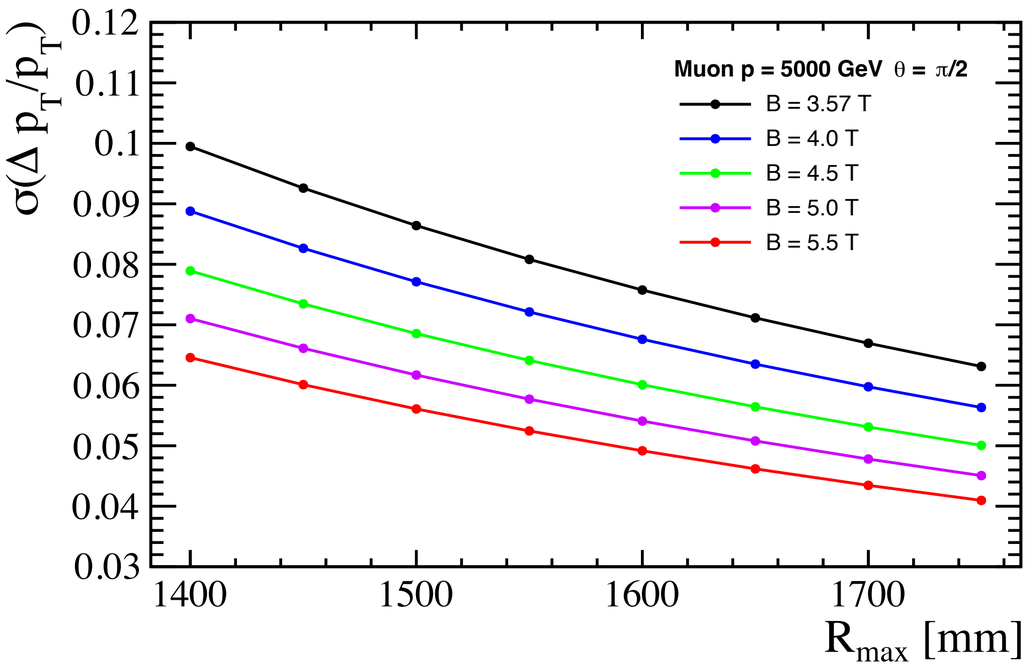



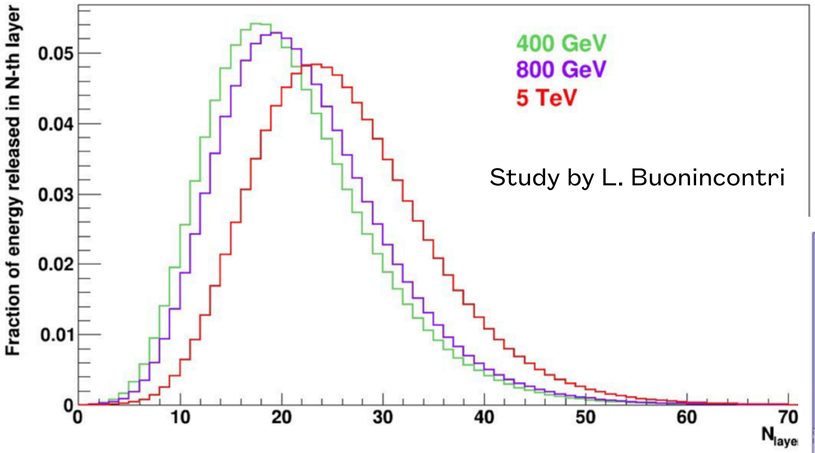
# Initial (preparatory) studies

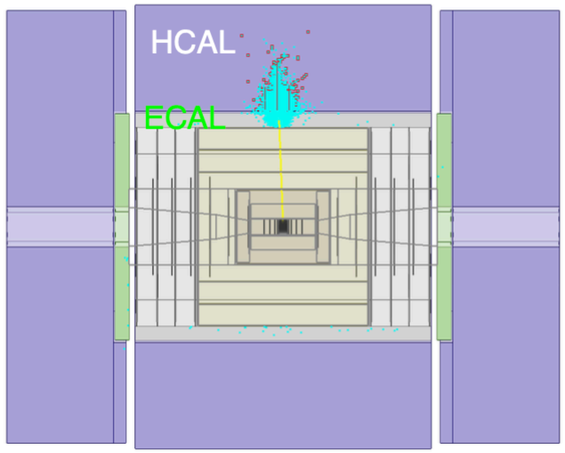
- Few studies have been done to properly understand the requirements of a 10 TeV detector

  - Track resolution as a function of magnetic field and tracker dimension




  - Calorimeters depth to contain electromagnetic and hadronic showers



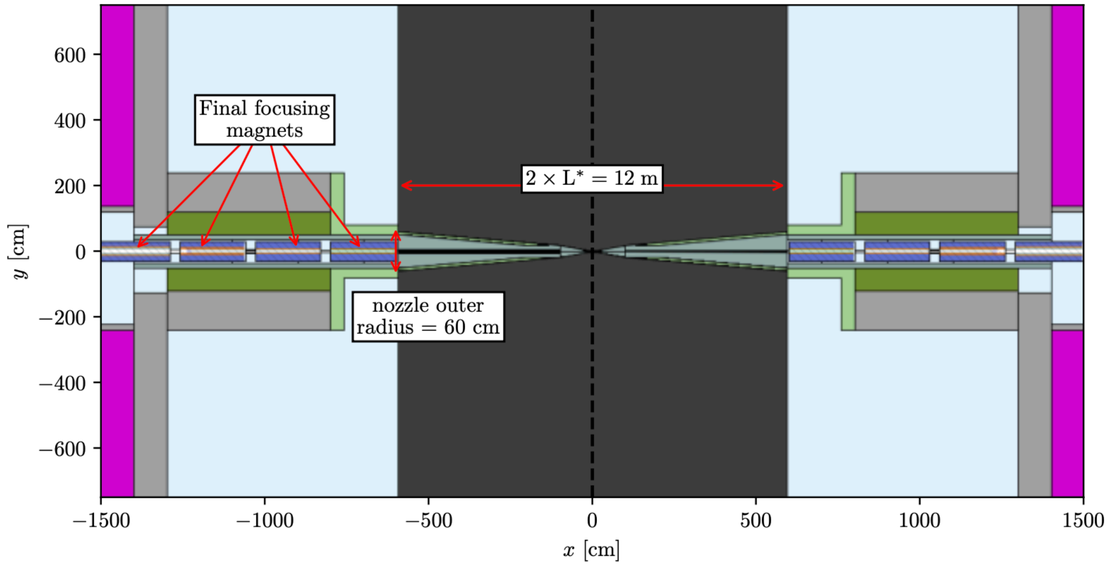



# General ideas behind the concept

- Therefore, the following ideas are considered to design the detector properly:
  - Switch to a 5 T magnetic field (seems reasonable after discussion with magnet experts)
  - Increase tracker dimension
  - Increase the depth of ECAL and HCAL, to improve shower containment

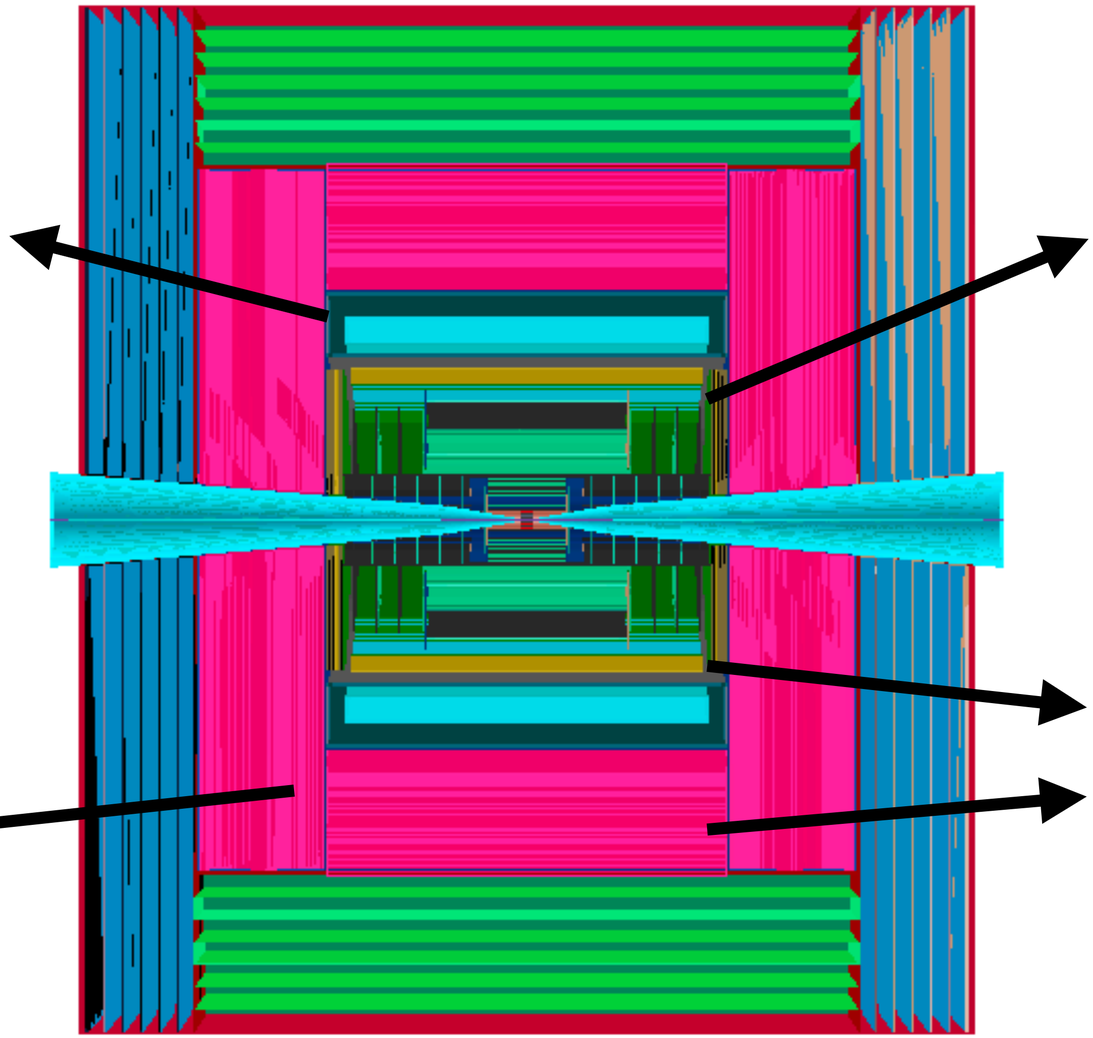
- This would pose a question: where to place the solenoid? **In between the calorimeters!**

- What doesn't change (yet)
  - Nozzles
  - L* (kept at 6 m)
  - Placement and number of tracker layers
  - Muon system



# The MuColl_v0_10TeV detector

5 T solenoid in between calorimeters: magnetic flux closed by iron in HCAL



Increased dimension of tracker (1500 → 1700 mm)

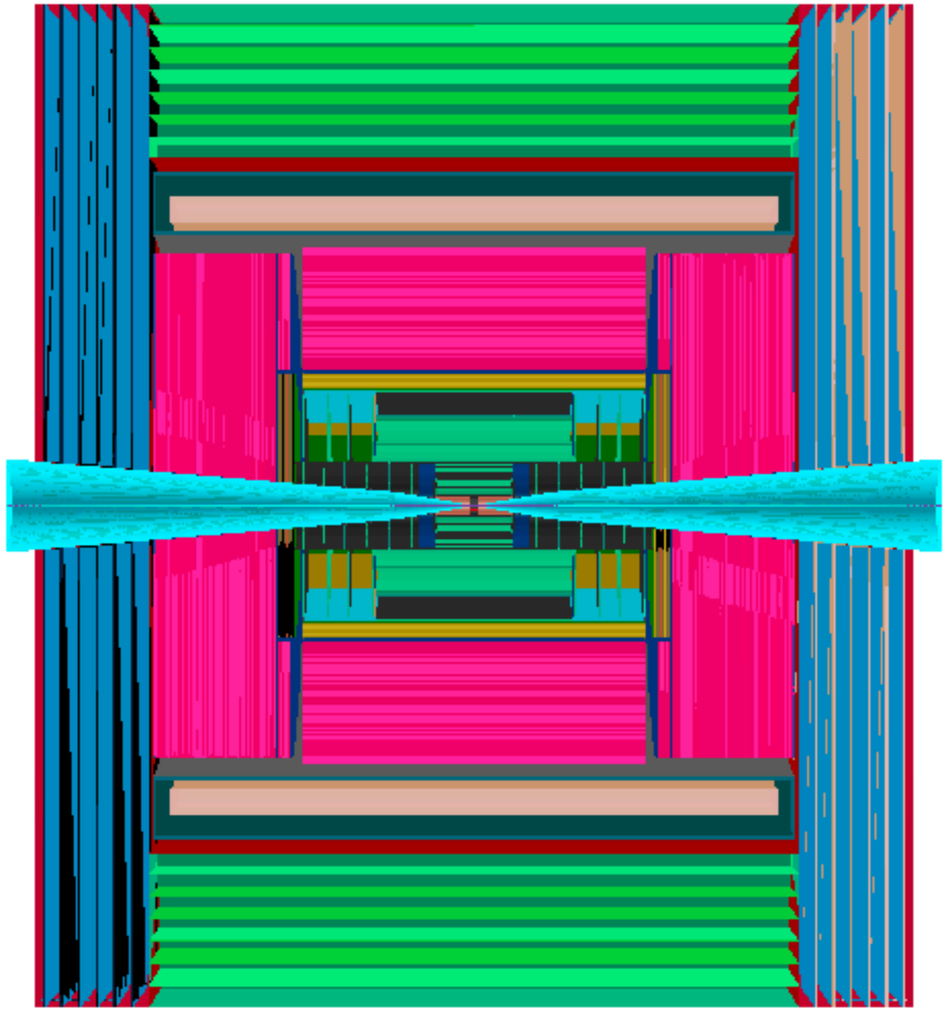
Increased dimension of calorimeters:

ECAL (40 → 51 layers)

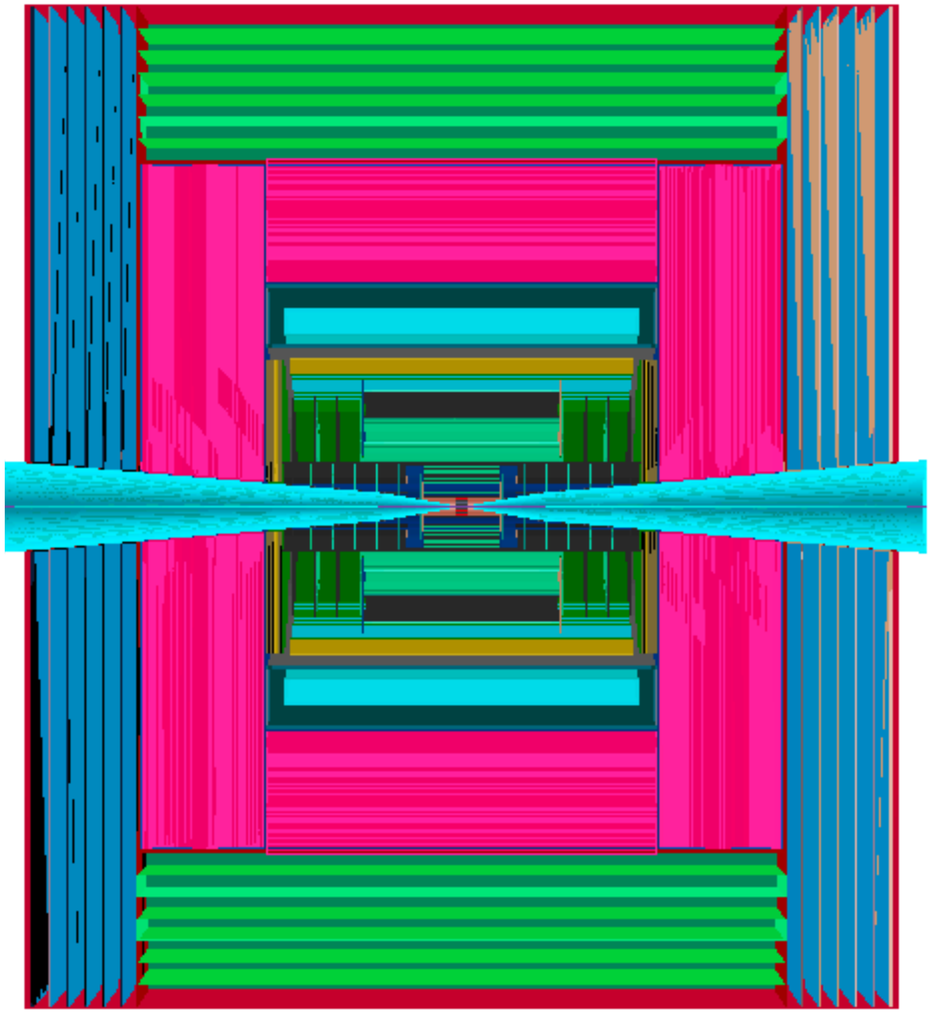
HCAL (60 → 70 layers)

Removed HCAL ring (not necessary)

# The MuColl_v0_10TeV detector



MuColl_v1

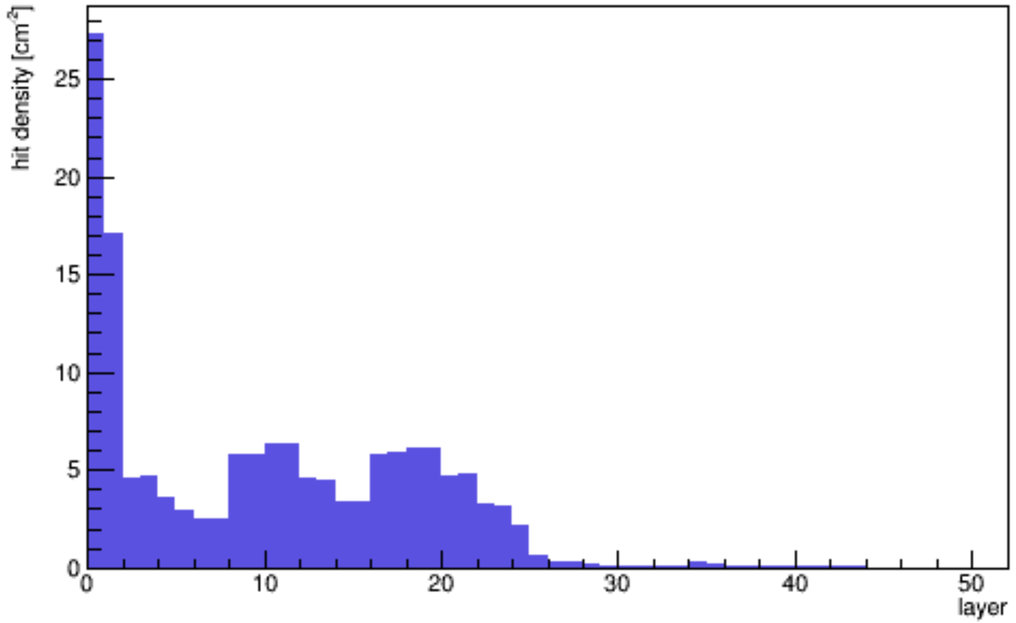


MuColl_v0_10TeV

# First test

- The pipeline to study the BIB occupancy is the usual one


- Unfortunately, the INFN cloud is in maintenance since yesterday, therefore no plots today :(




- This is a very preliminary plot showing the occupancy in the tracking system of 1/57 of 1 BIB event at 10 TeV
- Obtained with standard 3 TeV detector (MuColl_v1)
- Time range chosen: [-0.5,15] ns
- If multiplied by 57, comparable numbers with previous studies are obtained

# Conclusions

- The first “a la CLIC” configuration for a 10 TeV Muon Collider has been shown today
- Created a branch in the official MuColl repository
- There is a lot of work in the incoming weeks:
  1. Study detector performance without BIB using particle guns, to understand:
     - Detector coverage
     - Optimal efficiencies
  2. Same as 1. but with BIB
  3. Consider a couple of benchmark cases and study the physics reach
- Also, fundamental to have optimised nozzles for 10 TeV configuration